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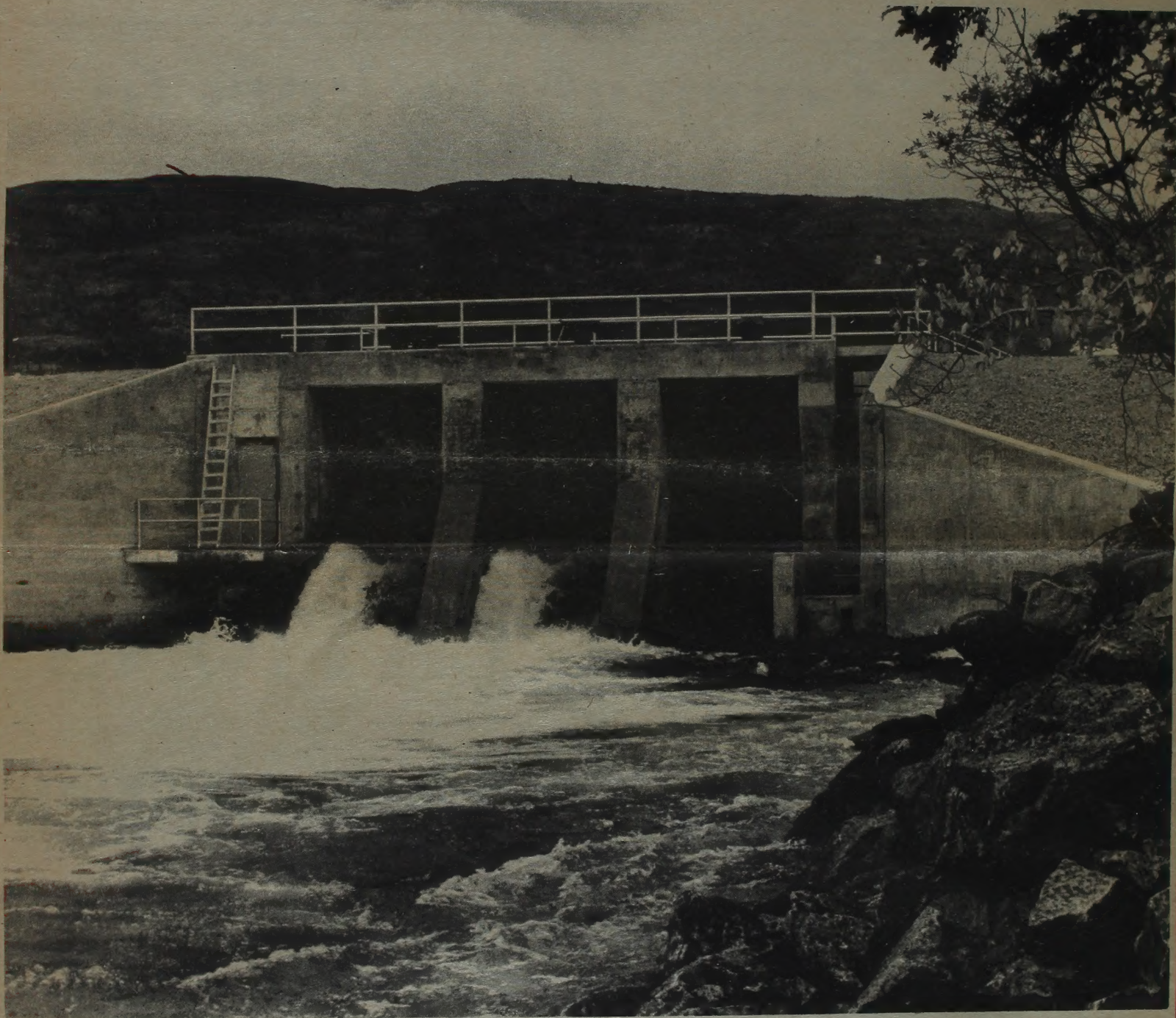
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AISHIHIK

Part of a Planned Program
Helping to Make the Future Bright
for Yukoners



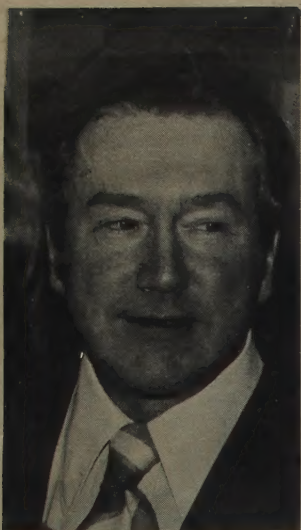
AISHIHIK LAKE DAM —Photo by Alan White



USING TODAY'S RENEWABLE RESOURCES
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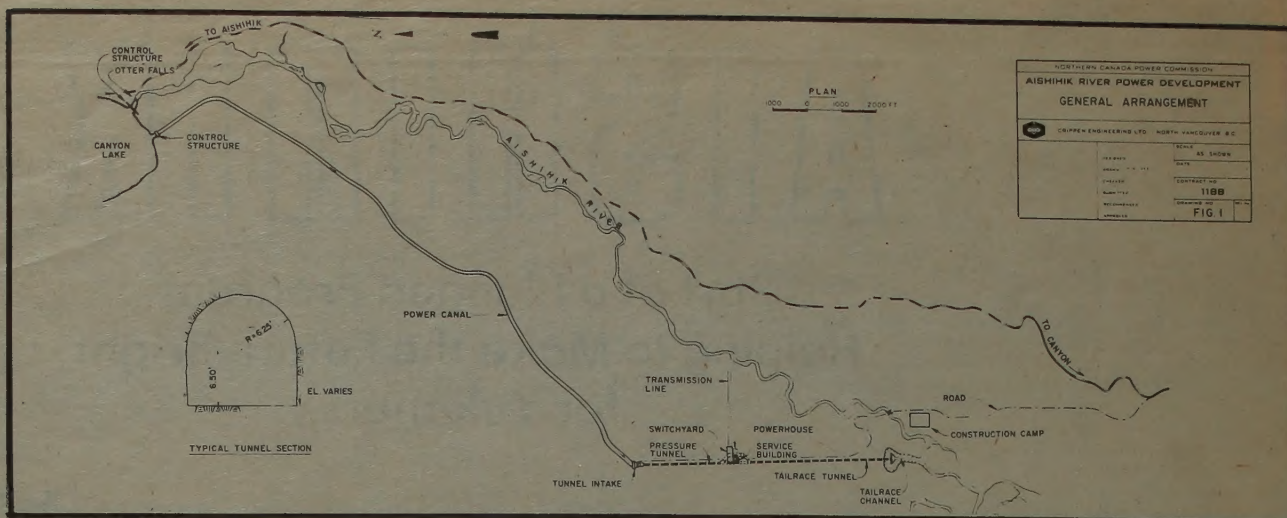


**Yukon
Territory
Commissioner
James
Smith**

Mr. James Smith, Commissioner of the Yukon Territory, was appointed Chairman of the commission on February 27, 1975.

Mr. Smith, who was born and educated in British Columbia, went to Whitehorse in 1947 and spent some 20 years there as manager of a food, motel and hotel business. During this period he also served as alderman in the city of Whitehorse and councillor, Yukon Legislative Council.

In 1966, he was appointed Commissioner of the Yukon Territory and has served in that position for the past eight years.



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**ON THE HISTORIC OCCASION OF THE OPENING
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The Future

Providing More Power For A Growing North

To provide economic energy to meet immediate load growth on the Whitehorse system, N.C.P.C. plans to add a fourth hydro unit to the present plant at Whitehorse rapids.

This unit of approximately 20-megawatts (MW) will generate energy from water presently not being used by the Whitehorse Rapids plant, providing optimum use of the reusable resources of the Yukon River. This fourth unit will provide the Whitehorse system with 60 to 70 million kilowatt hours a year by the year 1978.

The fourth unit can run at maximum capacity during the summer months when peak flows occur in the Yukon River.

This will complement the operation of the Aishihik plant where water is stored during the summer and regulated flows

during winter can provide base and peaking power for the Whitehorse system.

The Commission maintains a continuing program to review future demands for power and alternative sources of energy supply. Where alternatives are reasonably available, studies are developed to determine the most economic and feasible plans to meet the projected demand, compatible with social and environmental objectives.

The growing demand for energy in the Yukon has been identified to be in excess of 100-mw in a four-phase power study outlined below.

Phase 1, completed in early 1975, identified load growth—both industrial and domestic—provided an inventory of

available energy sources, and a selection of the more promising alternative energy sources for more intensive study.

This phase was given wide publicity in the Yukon, and public meetings have been held in several of the larger centres for the information of the public. By this means, the Commission expects to get some guidance from Yukoners as to their own priorities and preferences for such a power development.

Phase two of the power study, presently being undertaken, will examine the leading schemes in more detail, such as the engineering, environmental and economic feasibility of such a project. Sites to be considered during this phase include the Frances River, Granite Canyon

on the Pelly River, Five Finger Rapids on the Yukon River and Frazer Falls on the Stewart River.

Our consultants will recommend one of the above sites as being the most suitable for development.

Phase three will complete analysis of all factors pertaining to a large hydro-electric development which includes the presentation of data to support a water licence application of the Yukon Territory Water Board. These studies may take up to two years to complete.

Phase four will start and end with construction of the power plant.

In other locations, the pressure of highly inflationary costs has prompted further investigation to explore the feasibility of substituting hydro power for present diesel units. These locations include Coppermine, Fort Simpson, Frobisher Bay, Inuvik and Norman Wells in NWT and Dawson, Y.T.

While hydro-electric development is seen as the principal new source of power over the next 10 years or so, the Commission continues to examine all alternatives. A series of power inventory reports documenting all known sources of power, including hydro, thermal, and geothermal is in course of preparation. The Commission is also experimenting with wind-powered units and will test several 40-kw units at various sites over the next few years.

The use of natural gas or its residuals as an alternative to diesel fuel is under consideration for locations in the Mackenzie Valley likely to be close to such sources.

Inuvik electricity and heating plants; in particular, located close to the gas fields, could be converted from oil to gas should the alternative fuel prove to be more economical.

There are a number of considerations which guide the commission in making its choices. They include:

--- The most economic cost to the customer

--- The responsibility to assist in economic development

--- The social effects of the alternatives on the people in the area concerned, and

--- The environmental effects on plants, water, animals and the land.

All of these considerations are taken into account in the best interests of the people in the North.

Congratulations N.C.P.C.

on this historic occasion.

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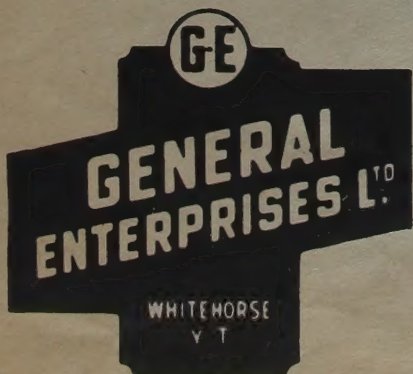
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TO

N.C.P.C.

ON THE COMPLETION OF THE

AISHIHIK RIVER POWER PROJECT



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Development of the North**

Power Development Is

No significant water seepages have been encountered in any of the underground excavations.

The only rock that does require support is at three places in the tailrace tunnel where major fault zones cross it. The rock there has been made soft and incompetent by shearing, brecciation and hydrothermal alterations.

These fault zones are relatively widely spaced along the tunnel, and only three are wide enough to have caused significant rock support problems. Narrower fault-fracture zones are not uncommon, but unstable rock at them has been readily secured by bolts, and, in some cases, straps. The zones account for five per cent or 250 feet of the total tailrace tunnel length.

None of these intervals resulted in rock support conditions that were not stabilized by normal installation of steel and timber sets.

The other 95 per-cent of the tunnel, as well as other underground excavations, required no rock support other than very minor bolting and strapping in very local, widely-distributed fractured areas.

Rocks in the power house and shaft are hard, tough, massive isotropic and are truly ideal for this installation. They needed no supplementary support at all.

The surge chamber and draft tube required no support either. In most underground excavations, it would be debatable whether such a rock pillar could be used. A narrow, tapered pillar two to six feet wide was left between the draft tubes

to separate water for the two turbines.

Yet at Aishihik, the pillar not only survived blasting of adjacent excavations but has not suffered any slabbing or over-breaks. It remains solid and unfractured.

Rock in the power tunnel is also as solid as in the others.

Licensing

The concept of developing the 600-foot head plant on Aishihik was developed by NCPC planners early in 1971. Application for a water licence was made by the Commission in August, 1971 under the Dominion Water Power Act and under section 6.2 of the Northern Canada Power Commission Act which states, the Commission is entitled to receive upon application any licence or other authority under the Dominion Power Act necessary to enable the Commission to carry out the provision of the Act.

Since the proclamation of the Northern Inland Waters Act was imminent, the licence application under the Dominion Water Power Act was not processed.

At the time, it was considered that the Northern Inland Waters Act would be operative before the end of 1971 and NCPC's application would be processed in time to allow construction to start in the summer of 1972. For these reasons, no licence was granted under D.W.P.A. and the Commission proceeded to apply under the Northern Inland Waters Act. The commission submitted an application for water licence through the Yukon Territory

Water Board on March 15, 1972. Aishihik thus became the first hydro development north of 60 to be processed under the N.I.W. Act and the authority of the Water Board.

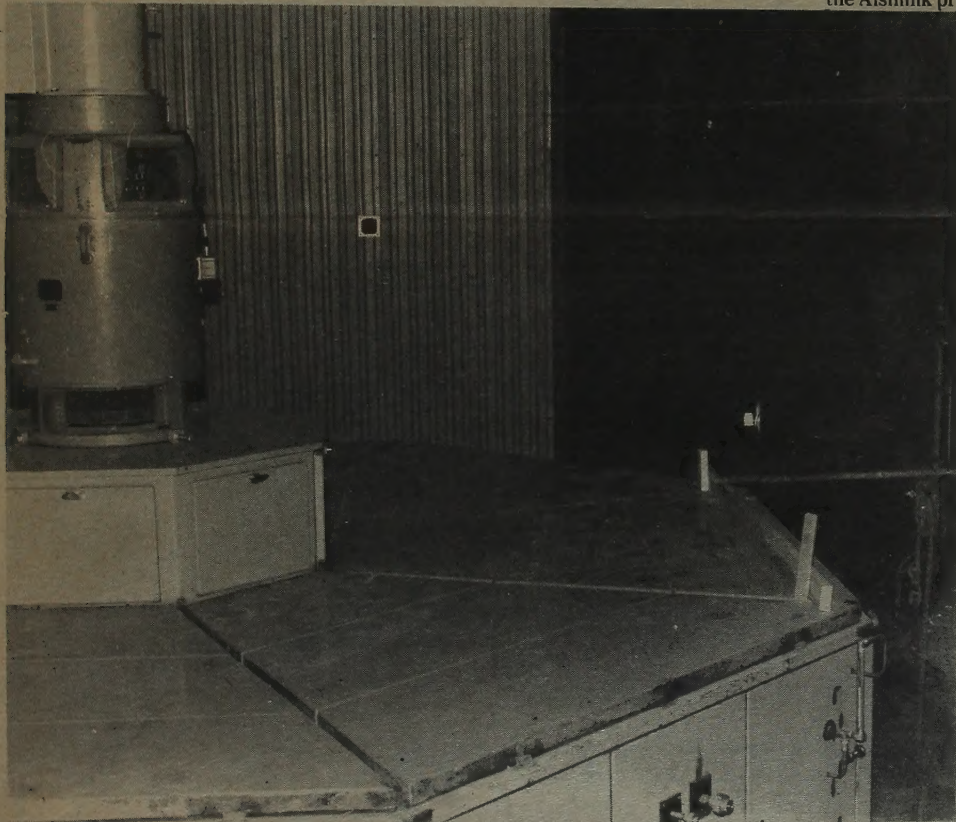
This application was processed by the water board and public hearings were announced.

The public hearings were conducted in Whitehorse and at Haines Junction in May, 1972.

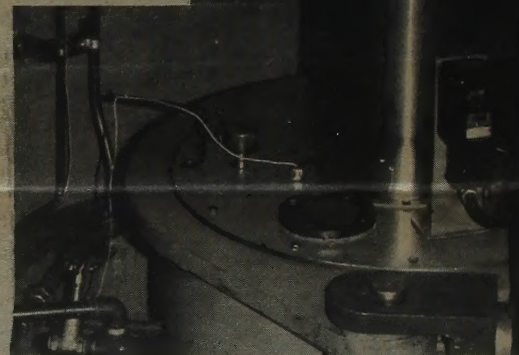
The proceedings of the public hearings are available in transcript form, a matter of public record, and are available from the Water Board. After considering the results of the public hearing, the Board agreed that there was a requirement for power development in the southern Yukon. However, in order to adequately assess the Aishihik River power development, the Water Board required NCPC to carry out further studies and surveys on the project.

Delays in the mechanics of proclamation as well as delays in the formulation of the regulations to the Northern Inland Waters Act meant that the Aishihik River power development could not be formally licenced at the time. The Act became operative in September, 1972.

Towards the end of 1972, the studies requested by the Water Board were completed and submitted to the water board. Upon consideration of the reports and studies submitted, the Water Board called for a second public hearing, held on Jan. 17, 1973 in Whitehorse. In April, 1973 the Commission received from the Yukon Territory Water Board a water licence for the Aishihik project.



One of Two Generators



A Turbine Shaft at Work

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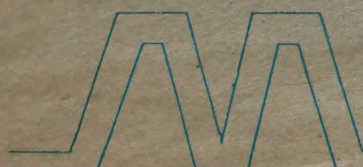
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Aishihik - What This Unique

Aishihik is a unique hydroelectric power development.

Built for the Northern Canada Power Commission from 1973 to early 1975, it takes advantage of large amounts of natural water storage in three lakes in the southwestern section of the Yukon.

Two turbines generate a maximum of 30 megawatts of electricity 350 feet below ground, the first underground hydro development north of the 60th parallel in the western world.

An 80-mile transmission line connects the development to NCP's Whitehorse grid system, which presently supplies Whitehorse, Carmacks and Faro. Extended transmission lines will bring Aishihik produced electricity to Haines Junction, Champagne, Canyon Creek and Ross River, which now rely on diesel generators for electricity.

Aishihik has the credit of being the first development licenced and approved under the Northern Inland Waters Act. It is also the first project to advertise publicly for any damages to individuals' property or livelihood.

The development takes advantage of natural water storage in the Sekulman, Aishihik and Canyon Lakes, about 75 miles west and 30 miles north of Whitehorse.

Water is diverted from a control structure at Canyon Lake along a three and one-half mile canal. It drops 600 feet and runs through a 3,000-foot pressure tunnel and penstocks before hitting the turbines.

From there, it flows 5,000 feet through a tailrace tunnel and channel to re-enter the Aishihik River system in the East Aishihik river.

The River System

The Aishihik river drains a total of 650,000 acres and runs 25 miles south from its headwaters north of Canyon Lake and drops about 900 feet to the confluence of the Dezadeash River at Canyon on the Alaska Highway.

Aishihik furnishes about one-third of the Dezadeash and Canyon Creek runoffs.

The West Aishihik river is the system's major tributary, draining 225,000 acres or 20 per-cent of the total drainage area. It is not regulated by any lakes, and its flows fluctuate widely with the seasons.

The Aishihik Lake area averages 15 inches of precipitation a year and 25 degrees above Fahrenheit. It lies in a zone of widespread and discontinuous permafrost which has been encountered from shallow depths down to 75 feet.

Annually, the river has discharged an average 526 cubic feet of water per second (cfs). Maximum was 5,050 cfs on June 20, 1962 and minimum was 79 cfs on April 18, 1952. Records have been made of flows for 20 years, at a manual gauge station 400 yards upstream from the Alaska highway bridge.

The East Aishihik River, which flows out of Canyon Lake, follows a narrow channel for about 200 feet before dropping about 35 feet over Otter Falls.

It cascades over a series of rapids below the Falls and empties into a shallow, 1,000-foot-wide oval-shaped Otter Lake, some 55 feet below Canyon. It then drops another 120 feet in the two-mile long meandering patch which varies in width from 29 to 50 feet to the top of Rainbow Falls.

Rainbow Falls is a cut through bedrock, dropping 120 feet in a chute 1,200 feet long. For the next two and one half miles the river continues to meander in a 15 to 50 foot-wide channel over several series' of rapids within the confines of a broad, steeply-banked and U-shaped valley, until it meets the West Aishihik River about 650 feet below Canyon Lake's elevation.

From there, it drops gradually to the Dezadeash River.

Project Design Construction

Storage for the project is regulated by two control structures — one at the outlet of Aishihik Lake and the other at the outlet of Canyon Lake, just above Otter Falls.

A small dam at Aishihik Lake is a gated concrete structure between low earth embankments. It is capable of passing a controlled water flow of 1,000 to 1,500 cfs, depending on the sill levels, and a peak flow discharge of 6,500 cfs. A designed flood retaining free board increment of three feet is provided.

A concrete fishway facility about 60 feet long allows fish to move from the downstream side to the upstream side of the Aishihik control dam.

At Canyon Lake's outlet, a small structure is needed to control the discharge into the river on an hour-to-hour basis. It is similar to an overflow weir, and is designed to blend in well with the surroundings so as not to distract attention from Otter Falls. It is not visible from the most popular viewing areas along the west bank of the river, below the falls.

At the beginning of the Power Canal, an intake structure of reinforced concrete was built. It has two openings sized to limit the water velocity to about three feet per second. Each opening was made com-

pletely below water level to avoid any ice blockage, and provision was made for closing the openings by a simple drop gate. It too will not be visible from the Otter Falls campground.

The three and a half mile long Power Canal from Canyon Lake was built along the west side of the Aishihik River valley. It has a capacity of 500 cfs, and has an area sufficient to limit water velocity to one foot per second, which assures that an ice cover will form early in the winter and avoid frazil and anchor ice problems.

The canal was constructed in permafrost on a sidehill with cuts as deep as 60 feet. It was excavated in two seasons and a dike was built on the downhill side using some of the 50,000 cubic yards of excavated material.

Its design was tailored to suit the varying conditions encountered with soils ranging from ice-rich frozen clay to dry frozen glacial till. Ice rich areas of soil which could slump or slide when warming action of water melts the permafrost have been over-excavated and backfilled with rock fill for stabilization.

Where previous soils were encountered a blanketing zone of compacted, low-permeability material was constructed. A protective lining of gravel was placed in the drawdown range on the dike side of the canal for wash protection on bends where wave action will be concentrated.

With a mean annual air temperature of 27 degrees Fahrenheit and recorded lows of -60 (F), considerable ice buildup occurs on the natural lakes. The canal was designed to operate with up to four feet of ice cover.

The excavation was completed in two stages. Stage One, fall of 1973, was a straightforward excavate-and-dump contract of about 450,000 cubic yards. As it was executed in the fall, the surface two to 10 feet of soil was unfrozen, requiring no ripping.

Stage Two, between April and December of 1974, comprised excavation of frozen soil and bedrock placement of compacted fill in the dike, and stabilization of ice-rich areas. Considerable difficulty was experienced in excavating ice-rich soils during the summer as they had become soft and very wet on thawing. Material for compacted, impervious fill had to be ripped, left to thaw, dried and placed. Wet weather during the summer severely restricted this operation, resulting in extra (thawed) borrow having to be obtained by widening the canal in selected areas.

Rock cuts presented problems because of permafrost, and holes in which water accumulated after drilling froze up.

requiring thawing before loading.

The canal was filled with water on Dec. 4, 1974.

At the end of the power canal, a vertical 30-foot-diameter intake shaft was constructed through bedrock, to a depth of 600 feet below the surface. A 3,000-foot pressure tunnel carries water from there to the powerhouse.

The powerhouse is 350 feet below ground level. Its chamber is 60 feet in height, 33 feet in width and 67 feet in length. The two turbines there discharge water directly through short, 20-foot draft tubes into a conical surge chamber, which measures 60 feet in length. It tapers from a height of 40 feet to a height of 11 feet at the entrance of the tailrace tunnel.

The tailrace tunnel measures about 14 feet by 14 feet in a cross section, and extends 4,756 feet through bedrock to an outlet portal to the Aishihik River.

The tailrace's open cut was made in the summer of 1973 to expose bedrock at the portal area. About 700,000 cubic yards of permafrost ground were excavated in a horseshoe-shaped cut, as much as 225 feet deep with slopes as steep as 1.5 horizontal and 1 vertical. A considerable portion of the upper soils was ice-rich silt with ice lenses several inches thick. Frozen glacial till soil was encountered at depth.

A lining of heavy rock was placed on the invert and partway up the slopes to provide stability, and to act as riprap under operating conditions. Ice buildup as much as 10 feet deep in the river and floodplain is one of the winter characteristics of the East Aishihik River. To prevent the tailrace channel from becoming plugged with ice, two training dikes or rock tunnel spoil were built across the flood plain for about 2,500 feet.

The general contractor for the canal and tailrace open cut excavation was General Enterprises.

Rock Excavations, Support

The project's underground openings are all within a gradational series of medium crystalline, massive igneous or igneous-derived rocks, ranging in composition of quartz diorite to diorite.

The crystalline rock within which the Aishihik excavations were made was so unusually sparsely jointed and infrequently fractured that it is excellent for tunnelling, wide-span excavations and precise shaping in mining. It required no supplementary support on walls or roofs, except for very minor local rock bolting and strapping where fracturing does occur.

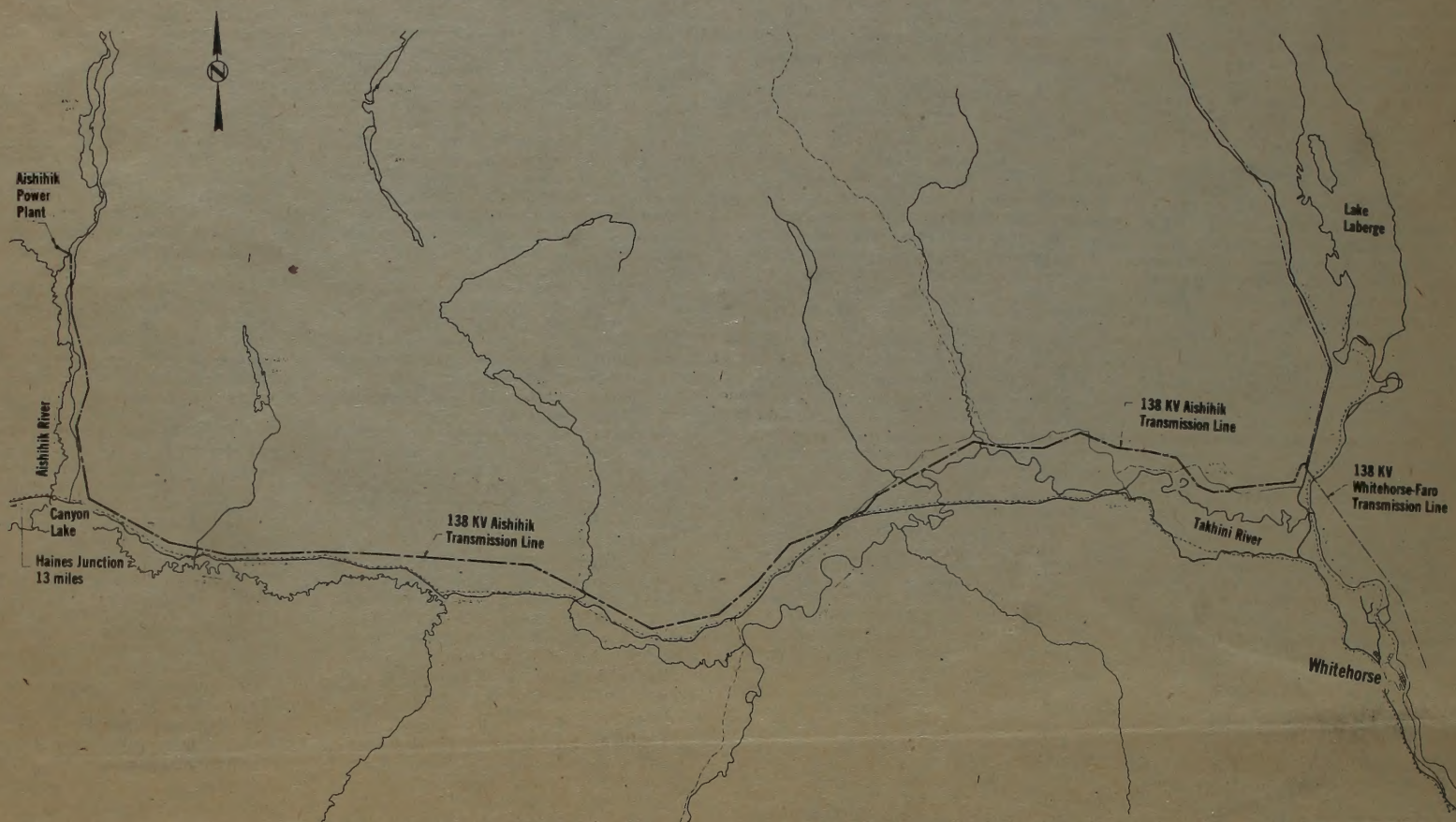
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The NCPC Story, From Birth

The Northern Canada Power Commission began with an Act of Parliament in June, 1948 as the Northwest Territories Power Commission (NTPC). It was set up to construct and operate electric power plants in the Northwest Territories for mining and other interests.

It is empowered today to survey utility requirements, construct and operate utility plants in the NWT and Yukon and, subject to the approval of the Governor General in Council (cabinet), elsewhere in Canada.

When the NTPC Act became effective in September, 1948, the commission assumed responsibility for the Snare River power project about 90 miles northwest of Yellowknife, NWT. That development was undertaken to aid and encourage mining around Yellowknife. In October, 1948, the Snare River plant began delivering power to its first customer, Giant Yellowknife Mines Ltd. Power was subsequently supplied to the town of Yellowknife and Cominco Ltd.'s "Con" mine.

The Commission was introduced to the diesel-electric business in 1949, when it started work on a central plant for Fort Smith, NWT, which until then had been served by three independent plants.

The same year, the NTPC Act was amended to allow the Commission into the Yukon Territory, and start work on the dam on the Mayo River near Mayo. Construction began in March, 1951, and ended in November, 1952. It was the first major

hydro power development in the territory. The dam supplied power to silver-lead mines being redeveloped at Keno Hill district near Mayo Landing.

Establishment of the next operation at Fort Simpson introduced NTPC to the heating, sewer and water utility field.

Those services, along with electrical utilities, were developed at Inuvik and Frobisher Bay. The environmental constraints of the North, particularly permafrost, resulted in the formation of a unique engineering design — the utilidor system of above-ground servicing.

In 1956, the Commission's name was changed to the Northern Canada Power Commission, reflecting its involvement in both territories. The same year, construction of a 15-megawatt hydro generating station at Whitehorse began. That was finished in 1958 and power was first supplied to the city in November, 1958 through Yukon Electrical Co. Ltd.

Between 1958 and 1960, NCPC designed, built and began operating a second hydro plant on the Snare River, 10 miles downstream from the first because of growing demand for power from both the mine and city of Yellowknife.

From 1960 to 1968, NCPC was charged with meeting industrial and domestic electrical demands with diesel generators at Ft. Resolution, Norman Wells, Coppermine, Aklavik, Fort McPherson, Baker Lake, Cambridge Bay, Chesterfield Inlet and Fort Good Hope in the NWT, Dawson City in Yukon, Field in B.C. and Moose

Factory in Ontario.

An 18-megawatt project was planned and built on the Taltson River in the NWT for the Pine Point mining area near Great Slave Lake between 1962 and 1965. The dam at Twin Gorges was connected to the Pine Point mines by a 175-mile transmission line via Fort Smith. The diesel unit at Fort Smith was reduced to standby operation.

Also in 1965, the Snare Rapids and Snare Falls plants were placed on remote control from Yellowknife.

In 1968, a third, eight-megawatt hydro unit was installed at the Whitehorse Rapids plant and a 225-mile transmission line constructed to the Anvil mine near Faro. An additional capacity of nine-megawatts of peaking, standby power was added with diesel units.

During 1970 and 1971, the Commission installed standby diesel in several communities, including Dawson and Whitehorse with the Whitehorse-Faro grid system increased by 5.1 MW.

Frank L. Mooney was chosen for the job of regional manager for NCPC's operations in the Yukon when the office was established in November, 1970. The NWT regional office was established in 1971, with Mr. A.O. Jones as manager. The two offices were established to improve internal communication, customer service, technical expertise and liaison. Eleven more communities were added to NCPC's responsibilities in the NWT.

One of the Commission's most challenging projects came in 1971-72, when it built an 80-mile, 69,000-volt, wood pole transmission line from Inuvik to Tuktoyaktuk in the NWT's Mackenzie Delta. It is believed to be the only transmission line of this type north of the Arctic Circle in the Western World.

Fourteen more communities in the NWT were transferred to NCPC from the NWT government during 1972 and 1973. The addition of them was the result of planned gradual withdrawal of the influence of the federal government from the territorial councils and commissioner. Negotiations with the NWT government will likely result in the acquisition by NCPC of yet more NWT power plants.

The Mayo plant got remote control from the town of Mayo in 1973, and the system contains provision for ultimate control of the plant from Whitehorse as the Yukon transmission grid is further developed. Rehabilitation of the Mayo Lake storage structure was also completed in 1973.

Power generation in the North has been primarily a matter of small, individual plants servicing an immediate area, with very little in the way of a transmission grid. To some extent, the forced

inadequacies of such a system has been overcome in the Yukon.

Here, a transmission line has been built between two of the major load centres. The mining area of Faro has been linked to the city of Whitehorse and to the Whitehorse Rapids hydro plant.

Continuing studies to assess the feasibility of a transmission link between the Aishihik Whitehorse Faro grid and the Minto-Mayo area will be conducted in 1974-1975.

During 1973, the Commission added a further six diesel-electric plants to its system. Five of these were taken over from the government of the NWT. The sixth, at Johnson's Crossing, Y.T., was installed at the request of the local residents.

Demand for electrical energy continued to increase. As a result of load growth and the acquisition of more plants, a further 17-MW of diesel-electric capacity was added to the system.

The past year saw a number of major extensions to the transmission and distribution systems, including the Aishihik-Whitehorse transmission link. This 80-mile, three phase, line operating at 138-KV connects the Whitehorse grid at Takhini, 16 miles north of Whitehorse. Further 34.5-KV extensions to the system are in progress and will connect Haines Junction via a 37-mile link from Aishihik and Ross River via a 43-mile link from Faro. These lines will provide the two communities with lower-cost hydro power and eliminate the need for diesel generation.

Growth of the economy in the Yellowknife area has increased the demand for power to the extent that standby diesel units in Yellowknife have been used to supplement hydro supplies at peak periods.

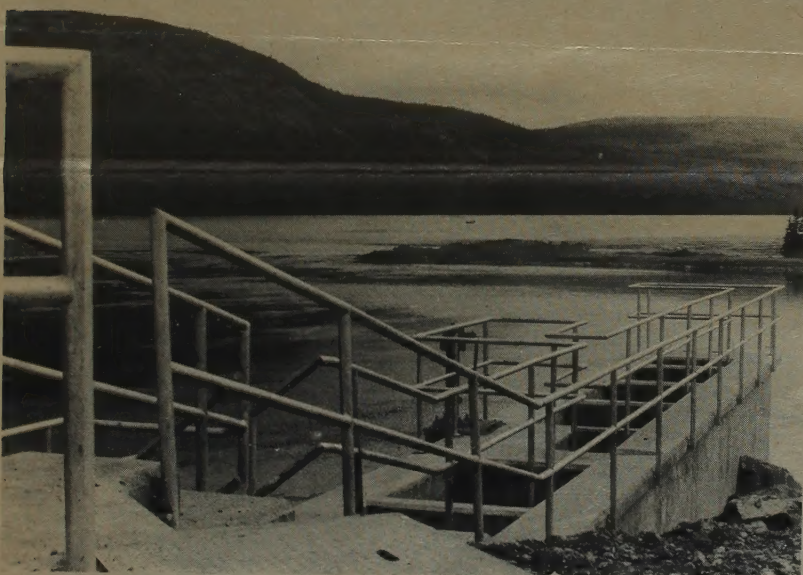
The sudden increase in fuel costs in 1973 advanced the need for additional hydro supplies, and resulted in a nine-MW hydro-electric development on the Snare River some 90 miles north of Yellowknife.

A second phase, at Snare Cascades, is expected to be on line in 1977. These two plants will provide an additional 13-MW to the Yellowknife system.

The two plants will be remotely controlled from Yellowknife. Control equipment will include a mini-computer which will assist in handling the large amount of technical data from the Snare plants.

A new control structure is under construction for Marsh Lake south of Whitehorse to replace the 25-year-old dam which is showing signs of deterioration.

Following public hearings before the Yukon Territory Water Board, the Commission received a water licence approving the new structure which is designed to permit fuller water control of the Yukon River.



Aishihik Lake Over the Fishway August 24, 1975 —Photo by Alan White

Congratulations to N.C.P.C. on their completion of the Aishihik Hydro-Electric Power Project

WE WERE PROUD TO ASSIST IN THE
DEVELOPMENT OF THE NORTH BY
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AISHIHIK

A NORTHERN CANADA POWER COMMISSION DEVELOPMENT

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OFFICIAL OPENING SEPT. 5, 1975



Offet Falls, August 24, 1975
—Photo by Alan White

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